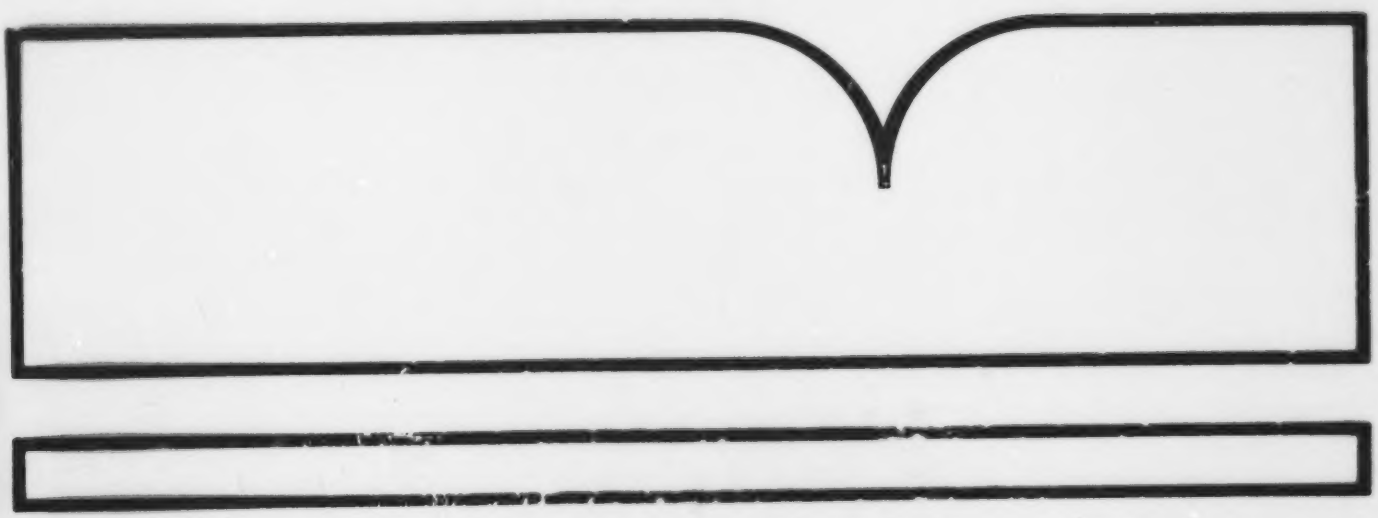
PB84-156462

Emissions and Fuel Economy of Turbo-Carb, a Retrofit Device

(U.S.) Environmental Protection Agency
Ann Arbor, MI

Aug 81



U.S. Department of Commerce
National Technical Information Service
NTIS

PB84-156462

EPA-AA-TEB-82-8

Emissions and Fuel Economy of Turbo-Carb, A Retrofit Device

Edward Anthony Barth

August 1982

Test and Evaluation Branch
Emission Control Technology Division
Office of Mobile Sources
U.S. Environmental Protection Agency

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-AA-TEB-82-8		PB84 156462

4. TITLE AND SUBTITLE	5. REPORT DATE
Emissions and Fuel Economy of Turbo-Carb, A Retrofit Device.	August 1981
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Edward Anthony Barth	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
U.S. Environmental Protection Agency Office of Mobile Sources Test and Evaluation Branch Ann Arbor, MI 48105	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
Same as box 9.	Technical
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This report describes EPA's testing of the "Turbo-Carb" device as part of an evaluation under Section 511 of the Motor Vehicle Information and Cost Savings Act.

The evaluation of "Turbo-Carb" device was conducted at the request of the U.S. Postal Service. The "Turbo-Carb" device is a one-inch thick carburetor adapter plate which inserts a mesh screen and swirl devices between the carburetor and intake manifold. The device is claimed to improve the preparation of the fuel/air mixture and thereby improve fuel economy and performance. Testing of three typical 1979 model year passenger cars was conducted at EPA's Motor Vehicle Emission Laboratory from March through May 1982. The basic test sequence included the Federal Test Procedure (FTP) and the Highway Fuel Economy Test (HFT). These tests were performed both without and with the Turbo-Carb Device installed. The overall conclusion is that there is no reason to expect that the Turbo-Carb device will significantly improve fuel economy or performance of a vehicle.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Fuel Consumption Exhaust Emissions Motor Vehicles Tests	Fuel Economy Gas Saving Devices	

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Release Unlimited	unclassified	21
	20. SECURITY CLASS *(This page)* unclassified	22. PRICE

EPA Form 2220-1 (9-73)

Abstract

This report describes EPA's testing of the "Turbo-Carb" as part of an evaluation under Section 511 of the Motor Vehicle Information and Cost Savings Act. The evaluation of this device was conducted at the request of the U.S. Postal Service. The Turbo-Carb is a one-inch thick carburetor adapter plate which inserts a mesh screen and swirl devices between the carburetor and intake manifold. The device is claimed to improve the preparation of the fuel/air mixture and thereby improve fuel economy and performance.

Testing of three typical 1979 model year passenger cars was conducted at EPA's Motor Vehicle Emission Laboratory from March through May of 1982. The basic test sequence included the Federal Test Procedure and the Highway Fuel Economy Test. These tests were performed both without and with the Turbo-Carb device installed.

The overall conclusion is that there is no reason to expect that the Turbo-Carb will significantly improve fuel economy or performance of a vehicle. Changes in fuel economy and emissions were small with mixed results of slight increases and decreases. Driveability remained essentially unchanged. Installation of the device was found to be considerably more difficult than claimed due to the requirement to design and fabricate several parts as well as perform critical readjustments.

Background

The Environmental Protection Agency receives information about many systems which appear to offer a potential for a reduction in emissions and/or an improvement in fuel economy in conventional engines and vehicles. EPA's Emission Control Technology Division is interested in evaluating all such systems, because of the obvious benefits to the Nation from the identification of systems that can reduce emissions, improve fuel economy, or both. EPA invites developers of such systems to submit information on the principle of operation together with available test data. In those cases where the system shows promise, confirmatory tests are run at the EPA Motor Vehicle Emission Laboratory in Ann Arbor, Michigan. The results of such test projects are set forth in a series of Test and Evaluation reports, of which this is one.

Under Section 511 of the Motor Vehicle Information and Cost Savings Act, EPA is required to evaluate devices which are claimed to improve fuel economy for the effects on both emissions and fuel economy. The results of these evaluations are published in the Federal Register.

The conclusions drawn from the EPA evaluation tests are necessarily of limited applicability. A complete evaluation of the effectiveness of a device in achieving performance improvements on the many different types of vehicles that are in actual use requires a larger sample of test vehicles than is economically feasible in the evaluation of test projects conducted by EPA. The conclusions from the EPA evaluation tests can be considered to be quantitatively valid only for the specific test cars used; however, it is reasonable to extrapolate the results from the EPA test to other types of vehicles in a directional manner; i.e., to suggest that similar results are likely to be achieved on other types of vehicles.

Introduction

In November, 1981, EPA received a request from Nancy A. Miller, a postal inspector for the U.S. Postal Service, for an evaluation of the "Turbo-Carb" device. EPA agreed to conduct this evaluation under auspices of the Section 511 process. Since EPA had no test data on which to base an evaluation of this type of device, the Turbo-Carb test program was part of this evaluation process. The Post Office provided the devices. The results of the EPA testing of the Turbo-Carb are contained in this report. The complete evaluation of the device is contained in the report entitled, "An EPA Evaluation of the Turbo-Carb Device Under Section 511 of the Motor Vehicle Information and Cost Savings Act," EPA-AA-TEB-511-82-12. The Section 511 report contains the complete evaluation and includes this test report as an attachment.

The Turbo-Carb is an adapter plate which inserts a fine mesh screen and swirl devices between the carburetor and intake manifold. It is approximately one inch thick. The device is claimed to improve the preparation of the fuel/air mixture and thereby improve fuel economy and performance. The sales literature/order form makes the following specific claims for the Turbo-Carb device:

"up to 38% increase - 5 more miles per gallon"
"smoother running engine"
"ping eliminated"
"improved performance"
"easy installation"
"less pollution of hydrocarbons"

Appendices G and H are two versions of the sales literature/order form.

The marketer of the device provided no test data to support these claims. However, since this evaluation and test program was undertaken at the request of the Postal Service, EPA did not require substantiating test data as a prerequisite to EPA testing.

Construction and Operation:

The Turbo-Carb consists of two carburetor adapter plates (each plate is about one-half inch thick), a fine mesh stainless steel screen and a stationary swirl prop for each venturi. The assembly is installed between the carburetor and intake manifold. The two plates form a hollow chamber with the screen sandwiched in the center of the chamber between the plates. Thus, although the screen restricts the fuel/air flow, this adverse effect is minimized by the large area of the screen. The stationary props are attached to the bottom plate (intake manifold side) and extend into the manifold. These props cause the fuel/air mixture to swirl and thereby promote mixing. A drawing of the device is given in the installation instructions contained in Appendix F to this report.

Purpose of the Test Program

The purpose of the EPA test program was to conduct a technical evaluation of the device to determine if the Turbo-Carb met its advertised claims, affected exhaust emissions, or affected safety. Emissions, fuel economy, and installation were to be specifically evaluated. The other claims - smoother running engine, ping eliminated, and improved performance - were to be evaluated by noting any changes in the operating characteristics of the test vehicle. No special test procedures were employed to evaluate these latter claims.

Test Plan

The EPA test plan consisted of the checkout of the three test vehicles, replicate baseline tests, device installation, and replicate device tests. The purpose of the vehicle checkout was to insure each vehicle was representative of a properly-tuned vehicle and would provide a reasonable reference test condition.

The vehicles were to be tested using the Federal Test Procedure (FTP) and Highway Fuel Economy Test (HFET). The FTP is the official EPA test procedure for determining the exhaust emissions of a vehicle. The results of both of these tests are also used to determine a vehicle's fuel economy. The FTP is described in the Federal Register of June 28, 1977 and the HFET is described in the Federal Register of September 10, 1976. The vehicles were not tested for evaporative emissions.

Installation was to be done per the instructions supplied with the device. Since the device raises the carburetor, it was expected to affect hood clearance and the carburetor linkages to the throttle, choke, and automatic transmission. Also air hoses, electrical leads, fuel lines and vacuum lines would require repositioning (relocating). Therefore particular attention was to be directed toward determining what modifications and adjustments are required to maintain proper operation of these components. The time required, ease of installation, and problems or hazards encountered were also to be noted.

Claims for the Turbo-Carb not specifically addressed by the test plan were engine smoothness, improved performance, and elimination of ping. The reason for not using specific procedures to evaluate these claims is because these are, in large part, subjective and the procedures for their measurement are neither well defined nor routinely used by EPA. These latter claims were to be evaluated only by having the drivers note any changes in the performance of the engine.

Since this 511 process was initiated by the government, EPA did not require the inventor/marketer of the device to concur with the test plan. However, he was informed of EPA's intention to test his device and was invited to observe the testing.

Three typical 1979 production vehicles were used: a Ford Pinto with a 4 cylinder engine, a Plymouth Volare with a 6 cylinder engine, and a Ford Granada with an 8 cylinder engine. All vehicles were equipped with automatic transmissions. A more detailed description of each vehicle is provided in Appendix A.

Conduct of Testing

The testing was conducted from March through May. All tests were performed by the EPA at its Motor Vehicle Emission Laboratory in Ann Arbor. The inventor/marketer was present during two days of the test program. In general, the testing proceeded as planned. However, because a baseline test sequence for the Pinto showed a greater than expected variation in fuel economy, two additional baseline test sequences were conducted on the Pinto. This baseline outlier (fuel economy unexpectedly high) was deleted from the data set. A scrutiny of the Volare data led to rejection of the two baseline HFETs. These two HFET's were rerun after the device was removed from the vehicle. Since the first two device test sequences on the Granada data indicated a possible benefit for the device, a third test sequence was conducted to obtain sufficient data to determine if the change was statistically significant.

Because the Granada data had indicated a possible fuel economy benefit, additional testing was conducted to determine if the change was due to the baseplate and readjusted linkage or to a combination of effects by the baseplate, adjustments, screen, and stationary props. For a final test sequence, the stationary props and screen of the device were removed and the Granada was retested.

There were problems encountered in installing the device on each vehicle. These installation problems are presented and discussed with the test results.

Test Results - Installation

The Turbo-Carb installation was performed by an EPA mechanic using the instructions provided with the devices (see Appendix F).

The installation of the Turbo-Carb devices raises the carburetor over one inch and many of the problems encountered were related to the carburetor being raised by the device. The specific problems encountered for each vehicle are given in Appendix E and are summarized below

The device interfered with the hood closing on one vehicle and caused a small dent in the hood when it was closed. The installer was alerted to this problem by the installation instructions.

It was necessary to design and fabricate extensions for the kickdown linkage between the throttle and automatic transmission for all three vehicles.

The throttle linkage needed to be modified on two vehicles.

The choke rod linkage needed to be extended and readjusted on one vehicle. These parts were not provided with the kit.

The device did not provide a leak proof seal on one vehicle and required application of a gasket sealer to stop this vacuum leak. Although the instructions do not allow the use of sealing materials, the inventor allowed us to use it. He cautioned against any on the screen.

Improper replacement studs were provided for two vehicles. These two vehicles required studs with metric threads but the kits only included studs with SAE threads. The inventor stated he provided metric bolts when required. However, the kits were ordered specifically for each vehicle yet the two kits still came with the wrong studs.

The installation instructions, Appendix F, state in step 11 that an extender for the manifold heat control choke rod tube was provided in the kit. However, none was enclosed in any of the three kits purchased.

The air hoses, electrical leads, fuel lines, and vacuum lines were able to be readily rerouted to the raised carburetor and air filter. Several metal lines had to be reworked, however no additional parts were required.

The instructions were generally adequate for the installation of the device. They addressed many of the problems the installer was likely to encounter when installing the Turbo-Carb. Only simple tools and normal mechanical skills were needed for the installation. However, the installer will have to design and fabricate hardware to allow the device to raise the carburetor linkages to function properly. The installer will also need access to the shop service manual for the vehicle in order to properly readjust the kickdown linkage to the automatic transmission. This adjustment is critical since it controls the transmission shift points.

Installation, including fabrication of parts and necessary adjustments, required from 2 1/2 to 8 hours.

Test Results - Fuel Economy and Emissions

The test results for each vehicle are summarized in Table I. Emission levels are listed in grams/mile while fuel economy is shown in miles per gallon. The individual test results for each vehicle are given in Appendices B, C, and D.

Table I
Summary of Test Results

		FTP				HFET			
Vehicle	Configuration	HC	CO	NOx	MPG	HC	CO	NOx	MPG
Ford	Baseline	1.18	4.20	1.58	22.3	.64	.70	1.37	29.1
Pinto	Turbo-Carb	1.29	3.74	1.64	22.3	.77	.87	1.33	28.7
	Average Change	+10%	-11%	+4%	-0-	+19%	+25%	-3%	-1%
Plymouth	Baseline	.71	6.63	1.24	19.2	.87	22.09	.57	26.2
Volare	Turbo-Carb	.60	6.08	1.26	18.9	.16	4.56	.45	25.9
	Average Change	-16%	-8%	+2%	-1%	-82%	-79%	-20%	-1%
Ford	Baseline	.88	4.73	1.46	14.5	.28	.51	2.21	20.5
Granada	Turbo-Carb	.99	4.23	1.52	15.2	.31	.31	1.96	21.4
	Average Change	+13%	-11%	+4%	+4%	+10%	-39%	-11%	+4%
Ford	Baseline	.88	4.73	1.46	14.5	.28	.51	2.21	20.5
Granada	Mod. Turbo-Carb*	.97	5.77	1.44	14.9	.25	.27	2.06	21.2
	Average Change	+10%	+22%	-1%	+3%	-11%	-47%	-7%	+4%

Note: Underlined values are statistically significant at a 90% confidence level. Mod. Turbo-Carb emissions were not analyzed for statistical significance.

These data were analyzed by several statistical methods (student's "t" test, paired "t" test, and 2 way analysis of variance) to determine if the changes were statistically significant for either an individual vehicle or a group of vehicles.

The student's "t" test is used to compare the sample means of two populations. It is useful when there are only a few data samples. It allows the data to be readily compared at a given confidence level. The individual test results given in the Appendix were compared (i.e., Pinto FTP baseline tests to Pinto FTP Turbo-Carb tests, Pinto HFET baseline test to Pinto HFET Turbo-Carb tests, etc.). This analysis showed that:

Pinto - Turbo-Carb did not cause a significant change in fuel economy for either the FTP or HFET.

---

*Modified Turbo-Carb: Only carburetor baseplate used, screen and stationary props removed.

Volare - Turbo-Carb caused a statistically significant decrease in fuel economy for both the FTP and HFET.

Granada - Turbo-Carb caused a statistically significant increase in fuel economy for both the FTP and HFET.

The modified Turbo-Carb also caused a statistically significant increase in fuel economy for both the FTP and HFET. Because this change was similar to that caused by the complete device, this may indicate that it is the chambered baseplate and linkage readjustments that caused the changes and not the stationary props or mesh screen.

The student's "t" test of paired data is used to sample means of paired observations. It is a more specialized usage of the "t" tests and has the same features as the "t" test. The averages given in Table I were compared for both the FTP (baseline vs. Turbo-Carb for the Pinto, Volare, and Granada as a group) and the HFET. This paired "t" test data analysis showed that there was no statistically significant change in fuel economy due to the Turbo-Carb device for either the FTP or HFET for the group of three vehicles.

The 2 way analysis of variance (2 way ANOVA) is used to compare the means when there are several test variables (i.e., for the FTP with or without device for several vehicles). It can be used to test if there is or is not a significant interaction between test variables. The 2 way ANOVA also showed that there was no statistically significant change in fuel economy due to the Turbo-Carb for either the FTP or HFET for the group of three vehicles.

Although fuel economy is largely influenced by vehicle weight and engine displacement, emissions are largely influenced by the emission control technology used by the manufacturer and this typically changes with model year. Therefore the emission data was analyzed only by the student's "t" test. The individual test results given in the appendix were compared (i.e., Granada FTP baseline tests to Granada FTP Turbo-Carb tests). This analysis showed:

Pinto - The Turbo-Carb caused a small but statistically significant increase in hydrocarbon (HC) emissions for both the FTP and HFET. It also caused a statistically significant increase in carbon monoxide emissions for the HFET. However, due to the relatively low level of the HFET CO emissions, the actual increase was very small.

Volare - The Turbo-Carb caused no statistically significant change in FTP emissions. The changes noted for the HFET are not significant because this vehicle has in the past shown considerable variability in HFET emissions, (HFET fuel economy has not been variable). This variability is apparently characteristic of the vehicle.

Granada - The Turbo-Carb caused a small but statistically significant increase in HC emissions for both the FTP and HFET. It also caused a statistically significant change in HFET NOx emissions. However, again due to the relatively low levels of these emissions, the actual increases were very small.

The changes due to the modified Turbo-Carb were not analyzed for statistical significance.

Test Results - Vehicle Performance

As noted previously, there were no special tests prescribed specifically for evaluation of vehicle performance. The drivers were simply requested to note and comment upon the operation of the vehicle. To insure a reasonable comparison, the same operator drove a given vehicle for both the baseline and device tests.

There were no changes in engine smoothness, or performance. None of the vehicles experienced ping with or without the device. The results are summarized below.

Table II
FTP Driveability

	Pinto	Volare	Granada
Baseline	soft spot in accel.	Good	Good
Turbo-Carb	soft spot in accel.	Good	slight soft spot in accel.

The starting was good for each vehicle for both baseline and with the Turbo-Carb device.

Table III
HFET Driveability

	Pinto	Volare	Granada
Baseline	Good	Good	Good
Turbo-Carb	Good	Good	Good

Overall, there was no appreciable change in vehicle performance caused by the Turbo-Carb device.

No safety hazards were observed with the device.

Conclusions

The overall conclusion is that there is no reason to expect that the Turbo-Carb will significantly improve fuel economy or performance of a vehicle. The Turbo-Carb failed to meet its advertised claims of "up to 38% fuel economy improvement" and "improved performance".

The fuel economy changes found on the three vehicles tested were small. Two of the vehicles showed either a decrease or no change in fuel economy and one showed a slight increase. Emissions were only slightly affected with mixed directional results. No improvements were observed by the test driver in the operating characteristics of the vehicles.

Installation of the devices was significantly more difficult than claimed. Considerable time and mechanical skills were required, several parts had to be designed and fabricated, and a number of critical readjustments had to be made.

Appendix A

Test Vehicle Descriptions

Make/Model	Ford Pinto	Plymouth Volare	Ford Granada
Model Year	1979	1979	1979
Type	2 door	2 door	4 door
Vehicle I.D.	9T11Y186165	HL29C9B217336	9W82F123952
Initial Odometer	26390	32280	26980
Engine:			
Type	Spark Ignition	Spark Ignition	Spark Ignition
Configuration	In-line 4	In-line 6	V8
Displacement	140 CID	225 CID	302 CID
Fuel Metering	2V Carburetor	1V Carburetor	2V Carburetor
Fuel Requirement	Unleaded	Unleaded	Unleaded
Emission Control System	EGR Catalyst	EGR Catalyst	EGR Air Pump Catalyst
Transmission	Automatic	Automatic	Automatic
Tires	BR78X13	D78X14	ER78X14
Test Parameters:			
Inertia Weight	3000	3500	4000
HP @50 mph	9.7	12.0	11.1

Appendix B

Test Results - Ford Pinto, 140 CID, 4 Cylinder

Test Date	Test #	Configuration	Federal Test Procedure HC	CO	NOx	MPG	Highway Fuel Economy Test HC	CO	NOx	MPG
3-25-82	2382	Baseline	1.21	5.14	1.62	21.9				
3-25-82	2383	Baseline					.62	.73	1.43	28.4
4- 1-82	2854	Baseline	1.16	4.44	1.51	22.2				
4- 1-82	2853	Baseline					.63	.72	1.30	29.2
4-15-82	2386	Baseline	1.16	3.01	1.60	22.8				
4-14-82	2362	Baseline					.68	.64	1.37	29.6
4-28-82	2388	Turbo-Carb	1.26	3.68	1.60	22.3				
4-28-82	2389	Turbo-Carb					.71	.87	1.35	28.6
4-29-82	2390	Turbo-Carb	1.32	3.80	1.67	22.3				
4-29-82	2391	Turbo-Carb					.82	.87	1.31	28.8

Appendix C

Test Results - Plymouth Volare, 225 CID, 6 Cylinder

Test Date	Test #	Configuration	Federal Test Procedure HC	CO	NOx	MPG	Highway Fuel Economy Test HC	CO	NOx	MPG
4-14-82	2374	Baseline	.76	6.99	1.25	19.2				
5- 6-82	2379	Baseline					.92	22.87	.59	26.1
4-15-82	2380	Baseline	.65	6.26	1.23	19.2				
5- 6-82	3306	Baseline					.82	21.30	.54	26.3
4-27-82	2375	Turbo-Carb	.62	6.49	1.25	18.9				
4-27-82	2381	Turbo-Carb					.15	4.12	.46	25.9
4-28-82	3142	Turbo-Carb	.57	5.66	1.27	19.0				
4-28-82	3141	Turbo-Carb					.17	4.99	.44	25.9

Appendix D

Test Results - Ford Granada, 302 CID, 8 Cylinder

Test Date	Test #	Configuration	Federal Test Procedure HC	CO	NOx	MPG	Highway Fuel Economy Test HC	CO	NOx	MPG
3-25-82	2357	Baseline	.86	5.09	1.43	14.5				
3-25-82	2358	Baseline					.28	.69	2.22	20.4
3-29-82	2359	Baseline	.90	4.36	1.48	14.6				
3-29-82	2360	Baseline					.28	.32	2.20	20.6
4-20-82	2363	Turbo-Carb	.96	4.90	1.45	15.1				
4-20-82	2364	Turbo-Carb					.30	.39	1.97	21.5
4-21-82	2365	Turbo-Carb	.95	3.99	1.57	15.3				
4-21-82	2366	Turbo-Carb					.31	.10	1.94	21.6
4-22-82	3065	Turbo-Carb	1.06	3.79	1.53	15.2				
4-22-82	3066	Turbo-Carb					.31	.17	1.97	21.3
5-4-82	3264	Mod. Turbo-Carb(1)	.96	5.70	1.51	14.9				
5-4-82	3263	Mod. Turbo-Carb(1)					.24	.14	2.22	21.3
5-6-82	3304	Mod. Turbo-Carb(1)	.97	5.84	1.37	15.0				
5-6-82	3305	Mod. Turbo-Carb(1)					.26	.40	1.89	21.2

(1)The Turbo-Carb was modified by removing the screen and stationary props for these tests.

Appendix E
Turbo-Carb Installation Details

Pinto

The long replacement intake manifold to carburetor bolts provided with the kit had SAE threads. However, the manifold required metric studs which had to be fabricated.

Installation of the Turbo-Carb required the use of the old 1/4" insulator gasket for throttle linkage clearance and this was covered in the instructions. However, the outside bolt hole flanges of the Turbo-Carb interferred with other manifold bolts and flanges. This problem was solved by filing 1/8" off the lower edge of this outer flange. This problem could also have been solved by the user purchasing and installing a second insulating gasket.

Fabricated extension for throttle to automatic transmission kickdown linkage and readjusted linkage.

Fabricated one inch spacer (including metric bolts) for throttle cable bracket.

With the spacer installed, the surfaces of the Turbo-Carb aluminum block halves were not true, thereby inducing a severe vacuum leak. The external application of a silicone sealer on the block mating surfaces did not cure the leak. The device was disassembled, the aluminum blocks halves were sanded true, and the silicone sealer was installed between all mating surfaces (being careful to ensure the sealer did not block screen passages). This cured the vacuum leak. Note the instructions specifically state "DO NOT USE GASKET SEALER ON FACE or MOUNTING SURFACE OF GASKETS!" According to the inventor this is to prevent the screen from being blocked by excess sealer.

Since the inventor was present at this time, he was informed that EPA intended to use a sealer to stop the vacuum leak.

The time required for the installation was 8 hours. this included the time required to fabricate the various hardware bits, readjust the linkages, and correct the vacuum leaks.

Volare

The Turbo-Carb device was installed on the vehicle using the long replacement intake manifold to carburetor studs provided.

Fabricated extension for rod from bimetallic choke to carburetor and readjusted choke linkage.

Fabricated extension for throttle to automatic transmission linkage and readjust linkage. With the Turbo-Carb installed the air cleaner stud interferred with the hood closing and would need to be about 1/2 inch shorter or the hood raised 1/2 inch.

The time required for the installation was 2 1/2 hours.

Granada

The Granada, like the Pinto, intake manifold also required metric carburetor stud bolts.

Bent and reworked manifold heat tube to meet raised choke coil.

Bent and reworked hot air tube from engine to meet raised air cleaner. Fabricated extension for the throttle to automatic transmission kickdown linkage and radjusted linkage.

This was the first vehicle on which the device was installed. Installation required 2 3/4 hours.

Turbo-Carb
FUEL-SAVING VAPOR ENERGIZER

IMPORTANT: PLEASE READ CAREFULLY, BEFORE INSTALLATION!

1. Check hood clearance between air-cleaner and hood on your vehicle: You will need 1 inch all models, except 4-barrel quad & spread bore, 1¾ inch needed, less present gaskets. TO CHECK, put thickness of fresh bread on high point of air cleaner. Close hood, open, and if bread is compressed, reduce, by thickness of present gasket to find needed clearance, and/or if possible to install on your vehicle. NOTE: Hood may possibly be adjusted at the hinges and latch, and/or insulation, if any, over the air cleaner cut out, to get added clearance.
2. Turbo-Carb is larger than some carburetor bases. Check for clearance around carburetor, humps or bolts sticking up on manifold, air-conditioning and other engine components that might prevent a good seal. A thicker gasket, size of carburetor base, may give you clearance.
3. Check length of mounting bolts enclosed in comparison to those of the engine. Must be 1 inch longer, 1¾ on 4-barrel quad and spread bore types. May be cut off, if too long.
4. Check length of gas line for height needed. Longer hose or metal line may be obtained from your local auto store, but probably will not be needed. On metal line, a splice of gasoline hose may be made by cutting metal line, slipping hose over ends, and clamping.
5. Check to see if you will need some large spacer nuts, washers and longer bolts to raise the mounting bracket of throttle control cables. Also check hose connections for extra length needed if any. Due to the many different applications we do not attempt to supply any of the parts. *ALSO*—On exhaust routhed METAL SPACER applications, *you may need a NEW GASKET* between spacer and manifold, generally a dealer stock item.
6. Gather all tools and parts needed before installation. For a more accurate TEST to find your mileage gain, you should test your vehicle right before installation of fuel saver and right after installation. As weather conditions and engine conditions can sometimes change, which may vary your results, put your vehicle in top condition before testing! By checking points, plugs, plug wires, distributor cap, rotor, coil condensor, air cleaner, PCV valve, carburetor and choke for proper adjustment, and engine oil. Replace needed parts. Use top quality parts, especially plug wires; one plug misfiring in a 4-cylinder engine is like losing 25% mileage upward and overloading the other 3 cylinders.

FUEL FACTS:

1. Radial tires have less rolling resistance, and will give you greater mileage. Also, wide tires and mud & snow tires will reduce your mileage. Keep tire pressure at maximum levels.
2. *At 50 MPH each 10°F. drop in temperature will lower gas mileage by about 2°.*
3. A 500 lb. gain in weight tends to reduce fuel economy by between (2) and (5) miles per gallon. A 2,500 lb. car will tend to get twice the gas mileage of one weighing 5,000 lbs.
4. An automatic transmission can reduce fuel economy by up to 15%.
5. A 10% increase in your speed (from 50 to 55 MPH) will require a 33% increase in the horsepower, and more fuel needed to overcome AIR RESISTANCE.
6. LOW OCTANE GAS, OPEN WINDOWS, ACCESSORIES ON, WET or SNOW-COVERED PAVEMENT, UPGRADED PAVEMENT, CROSSWIND OR FRONTAL WIND ALL tend to reduce mileage, possibly up to 5 MPG.

HOW TO TEST MILEAGE

It is probably impossible to get an accurate test of city driving, due to traffic jams, more or less stops and more or less waiting time. For a more accurate test, pick a calm non-windy day, drive to the nearest NON-stop highway or interstate where there is a fuel station and fill your vehicle's tank to ½ inch from entrance of fill spout. Some vehicles take time to do this due to air entrapment. Write your mileage down. Each TEST should have the same weather, temperature and road conditions, the same LOAD and tire pressure. Move out easy on the accelerator and try to drive at an even 50 MPH in all tests. Drive 20 miles or more from start, then return to same fuel pump, same station, same spot. As many stations have their paving downgraded in various directions, which makes it possible for your fuel to find a different level in your tank, or air entrapment. Refill tank as before. Then divide the number of miles traveled, by the number of gallons used. Figure to the nearest 10th of a gallon and mile. Remember your best mileage is when it's hot and humid. If temperature fluctuates between tests, you can calculate it by using the 2° formula as previously mentioned.

INSTALLATION INSTRUCTIONS

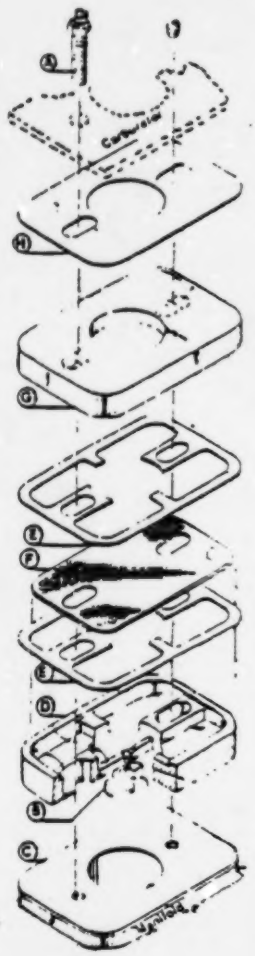
1. Check manifold vacuum at idle before removing carburetor. NOTE: A vacuum gauge is a low cost investment to analyze and adjust your engine.
2. Remove air-cleaner, and hoses to air cleaner.
3. Remove throttle control cables and transmission linkage if any.
4. Disconnect gas line at carburetor.
5. Make diagram of carburetor, and all connecting hoses. Identify each hose with white tape or labels, numbered or etc.; then remove from carburetor.
6. Disconnect electric choke, or manifold heat control rod. Remove throttle springs and any other connections to carburetor.
7. Remove mounting bolts and lift carburetor off. Handle carefully so as not to damage any part. Also, be careful and don't drop any parts into manifold! Now check turbo-carb for bolt hole location on your old gasket. Some models have thin KNOCK OUT TABS in castings and gaskets if needed. Knock out ONLY the parts that BLOCK old mounting gasket HOLES. Tap metal knock

outs towards the inside of hole with screwdriver and hammer. SPECIAL INSTRUCTIONS, Model 2 and 2A ONLY: On some engines you may need to use your old insulater gasket for throttle linkage or prop clearance—check before tightening carburetor down! Enclosed in kit is an extra '/₃₂ gasket, which will allow you to use a gasket on each side of your old insulator gasket. On Model 2 (ONLY on carburetors with throttle linkage on long straight side of turbo-carb), you may need to break off lip overhang on TOP SECTION ONLY, for linkage clearance. Use pliers, break lip downward from face side and file off rough edges.

8. DO NOT USE GASKET SEALER ON FACE or MOUNTING SURFACE OF GASKETS! Clean manifold and carburetor flange surface. NOTE: If you have exhaust roughted or water heated spacer, check spacer walls for possible pits or holes in walls. Also, replace spacer to manifold gasket with a NEW ONE, generally a dealer stock item. Install metal E.G.R. plate or SPACER if your engine is equipped with one.

9. Install stud bolts, and bottom section of fuel saver. Use ruler and locate center of bar in each manifold hole. Mark with pen or pencil. Remove bottom section and mount stationary prop on each center mark as follows: Spread cotter key just enough to go over bar, push all the way down, pinch together under bar with pliers, insert through prop with large hole towards bar and cotter key in slot. Holding prop firmly, use knife, spread cotter key and with needle point pliers, twist each leg of cotter key over the side, using the shaft as leverage to tighten. (NOTE: Prop must fit centered on bar in each manifold hole without side movement possible for best results.) Subject to heavy turbulence.

A. Install *thin bottom gasket*, part (c)
B. Install bottom section, part (d), check alignment of bore holes
C. Place frame gasket, part (e) on top of bottom section
D. Place screen, part (f) on gasket (e)
E. Place frame gasket, part (e) on top of screen (f)
F. Place top section, part (g) hollow side down on top of gasket (e)
G. Must use *thick gasket* (h) on top section for screen clearance (g) IMPORTANT: Before mounting lay OLD gasket on your NEW gasket. Check to see if any cut outs or holes through your OLD gasket are BLOCKED; if so, mark. You will need to drill same size through new gasket and top section of fuel saver, or make a channel in new top gasket over to the throttle bore hole. *These vacuum passages are necessary and your vehicle may not run if BLOCKED.* (Hondas have hose connections on their mounting gaskets. You will need to use your old spacer gasket in this case.)
H. Keep gasket alignment with turbo-carb around all edges flush and place carburetor on gasket (h) and nuts on studs. IMPORTANT: Fasten carburetor by alternately tightening each nut a little at a time, evenly, so as not to WARP your carburetor mounting flange. Tighten to OEM recommendations. Do not OVER TIGHTEN. Main throttle plates and shafts and vacuum operated secondary throttle plates MAY NOT OPEN if the BASE is WARPED, or may BIND.



10. Reverse procedure of disassembly of attachments to carburetor.
11. If you have manifold heat control choke rod, cut into at center of longest vertical part of rod and install tube extender enclosed. Cut to desired length, with distance of length of rod as previously determined in preliminary instructions No. 1, allowing tube '/₂ inch slipover on end of rods.
12. Be sure heat hose to air cleaner is installed and thermostat therein is working properly. *The air must be kept hot in order to get the best efficiency from your FUEL SAVER!* Always use air filter to protect screen from blockage and keep your engine clean, and prevent fire in the carburetor.
13. IMPORTANT: Be sure gas line is attached to carburetor. Check to see if throttle cables, choke rod, throttle springs and plates all move freely without any binding all the way to full throttle. You may need to raise throttle cable mounts and other parts where necessary.
14. Start engine. Check for fuel line leaks.
15. If engine does not idle properly, and all hoses to carburetor and air cleaner are connected, check for air leaks around gaskets and check to see if choke is properly set. See that throttle lever sets against idle-stops and choke is all the way open after engine has completely warmed up, and closed when cold. Also check manifold vacuum as in the beginning and compare. Gasket and hose connections may be checked for leak by using un-lit propane torch. Engine will speed up if leak, may be sealed by using HI-temp buytle type gasket sealers on the edges (stocked by auto stores). A bad vacuum leak can cause your engine to run rough, foul your timing and cause your engine to use more gas! Check cruise control chain if you have one. If too loose, cruise control may not work properly. If too tight, will not let throttle touch idle stop.
16. Generally NO engine modifications are NECESSARY. TIMING may possibly be set up for even greater savings due to the ATOMIZED, VAPORIZED MIXTURE. DO NOT MOVE TIMING, unless you are equipped with knowledge and timing equipment to do so! Maximum advance of manufacture recommended.
17. CONGRATULATIONS: You are now ready for a second mileage test, and greater mileage and performance! REPEAT: As in the first test EXACTLY the SAME. Good luck and tell your friends about your mileage gain! (Don't forget to put your BUMPER STICKER on your vehicle!) We appreciate comments and testimonials — *Thank You.*

MAINTENANCE: Primary throttle bores are self-cleaning, but secondary are not in constant use and may possibly load up with varnish. An occasional shot of carburetor cleaner will rid any build up.

THE 55 M.P.H. SPEED LIMIT WILL SAVE GAS AND MONEY!

The U.S. Dept. of Transportation has rated a 4,000 pound car for gas consumption relative to speed. Results showed that the car got 11.08 m.p.g. at 70 m.p.h.; 13.67 m.p.g. at 60 m.p.h.; 16.98 m.p.g. at 50 m.p.h.; and 14.89 m.p.g. at 40 m.p.h. Maximum mileage was reached between 50-55 m.p.h. Speed above and below did not save gasoline.

INCREASED GAS MILEAGE

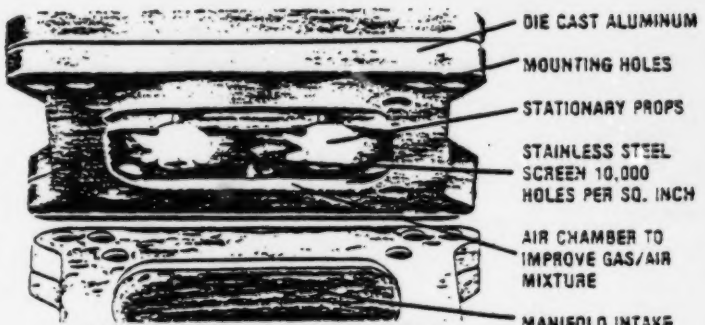
Turbo-Carb

FUEL-SAVING VAPOR ENERGIZER

U.S. PATENT NO. 4,163,436

Customers Report

Up to 38% Increase—5 More Miles Per Gallon—Smoother Running Engine—Improved Performance—Ping Eliminated—Easy Installation. THINK OF IT! Even a 10% INCREASE would be like receiving 12 cents EXTRA GASOLINE per gallon that you buy at $1.20 per gallon! Don't be fooled by the claims of those who offer devices to increase mileage, but actually restrict the flow of air and reduce engine power. (Window Screen (256) holes per sq. inch, BLOCKS OUT about 40% AIR FLOW). The PATENTED TURBO-CARB compensates for AIR restriction by redirecting the flow of air from the carburetor through an Enlarged Air Chamber. CARBURETOR MANUALS say, 1. Raising your Carburetor Up, 2. Atomizing the Fuel for better Vaporizing, 3. Giving the Fuel Mixture Turbulance, ALL tend to give IMPROVED Distribution, Economy, Performance, Less Pollution and Longer Engine Life. TURBO-CARB Provides ALL (3) of those FEATURES! Place a drop of liquid on your hot intake manifold and watch it spread out, but a fine micro-size speck will instantly vaporize! A course spray and large drops of fuel pass from carburetor into intake manifold, making it almost impossible to completely vaporize and mix with the right amount of air. You see why much of your fuel is wasted and not burned! That's one reason car manufacturers use a catalytic converter in the exhaust system to burn the unburned gas, which should have been burnt in the engine! With the PATENTED TURBO-CARB fuel saver, large liquid droplets of fuel are broken into a fine micro-size particles. With a potential of 10,000 per square inch! This makes the fuel much easier to vaporize, while a stationary prop provides propulsion turbulence to mix and direct the "fog-like" atomized fuel against the hot intake manifold walls, for more complete vaporizing, energizing and economy! With less pollution of hydro carbons and longer engine life! TURBO-CARB fuel saver has unique PATENTED FEATURES! Why not SPINNING PROPS? Because the AIR FLOW Controls the Props, SO Where's Resistance to cause Turbulance and Mix? STATIONARY PROPS Tested an Increase over the Spinning Props! There are no moving parts to wear out, or electrical parts to burn out. Screen—RED HOT 5 Min. BLOW TORCH Tested without any defects except discoloration! Also designed to prevent stalling of engine from the possibility of temporary icing of screen during warm up. And it's safe when properly installed. Mounts under carburetor, mounting instructions, bolts and gaskets included.



MADE FOR AMERICAN AND FOREIGN VEHICLES

FREE 60 DAY TRIAL—If for any reason you are not fully satisfied with your purchase of a TURBO-CARB, return within 61 days after delivery for FULL REFUND, installation or removal excluded. FREE Part replacement available up to (1) year in event of Defects in Material and/or Workmanship, installation, removal, or reinstallation excluded.

TESTIMONY

*On a 77 Chevy Van I was getting 15 mpg, it increased to 20 mpg, my Performance Improved, it took the "Ping Out" and the Installation was Easy.—**Gene Glaze, IN**

*I am really thrilled about it! Gas mileage is really improving on my '73 Chev. Wagon. My performance has improved.—**Charles Woolard, Indiana**

*I am very pleased. It not only did what you said, but also makes my motor on my Subaru wagon run MUCH smoother! They are a Real Gas Saver!—**Roy Briskey, TN**

*It's hard for me to believe the results I'm getting on my '77 Ford LTD. I went from 10 to 13.8 mpg, about 50% highway and 60% city driving with a lot of idling. Again thanks for a superb product.—**Mr. Philip Sirota, New York**

*For a '76 Ford Granada, it increased our mileage about 4 M.P.G. Enclosed check for a 1981 Ford Pick-Up—**Henry Lilly, Birch Tree, MO**

PLACE YOUR ORDER NOW! As there is a LIMITED SUPPLY. Order one for each vehicle! And Save! Postage and handling PAID with order of two or more TURBO-CARBS!

HOW TO ORDER:

1. Check which model needed below. Must know the number of barrels, as single and double/or double and four barrel are sometimes standard on the same engine model.
2. Check hood clearance between air-cleaner and hood on your vehicle. You will need 1 inch all models, except 4-barrel quad and spread bore, 1 3/8 inch needed, less present gasket. To check, place MODEL thickness of dough ball on high point of air cleaner, close hood, open: if dough ball is compressed, reduce by thickness of present gasket to find needed clearance, and/or if possible to install on your vehicle.

NOTE. Hood may possibly be adjusted at the hinges and latch, and/or insulation if any over the air cleaner cut out to get added clearance.

MODEL	DESCRIPTION:
No. 1	SINGLE BARREL (2-bolt only), US and FOREIGN makes, including side-draft model carbs.
No. 2A	DOUBLE BARREL—Honda, Datsun, Toyota (except 20 and 22R engine), Mazda, Opel, Audi, Subaru, Volkswagen Rabbit, Dasher, Scirocco
No. 2	DOUBLE BARREL (2 & 4 bolt), Most US makes (except GM 1979-81 6 cy 250, AMC & GMC 1980 & 81 4 cy 151 and V6 173, and those listed in Model 2B) FOREIGN makes—Luv, Fiesta, Dodge Colt, Challenger, Plymouth Arrow, Lancer, Sapporo, Capri, Courier, Fiat, Volkswagen with Holly 2110 carb
No. 2B	DOUBLE BARREL—GMC V8 1979-81 196, 200, 229 and 231 engine 4" base; GMC V8 1977-79 301, 1978-81 260, 1979-81 267 and 305 engines
No. 4	FOUR BARREL—AMC & Jeep V8 1967-74, GMC V8 1957-66, Chrysler V8 1964-72 single carb except Carter TQ, Ford V8 1957-74 except 351CJ & 460 Police
No. 4O	FOUR BARREL, Spread Bore & Quadrajet—AMC & Jeep V8 1975-76, Ford V8 1975-81 and 1972-74 351CJ and 460 Police, GMC V8 1966-81 Quadrajet, Chrysler V8 1971-81 Carter TQ carb.

FUGETT PRODUCTS CO., INC. R.R. 2 BOX 221 GASTON, IN. 47342

MODEL:

1 ☐	2A ☐	2 ☐	2B ☐	4 ☐	4O ☐	
$29.95		$34.95		$39.95		$ _____

Plus $2.50 Postage and Handling $ _____

IN. Residents Add 4% Sales Tax $ _____

☐ CHECK ☐ MONEY ORDER TOTAL $ _____

YEAR	MAKE	MODEL	ENGINE SIZE

MAILING LABEL — PLEASE PRINT

NAME: _____

ADDRESS: _____

CITY: _____ STATE: _____ ZIP _____

DEALERS Invited - Purchase a Sample, Credited as a FREE Sample on Initial Order of Approved Dealerships!

NTIS is authorized to reproduce and sell this report. Permission for further reproduction must be obtained from the copyright owner.

NOT FOR SALE IN CALIFORNIA)

Copyright 1980 by FUGETT PRODUCTS CO., INC. ALL RIGHTS RESERVED

INCREASED GAS MILEAGE UP TO 35% WITH Turbo-Carb

FUEL-SAVING VAPOR ENERGIZER

U.S. PATENT NO. 4,163,436

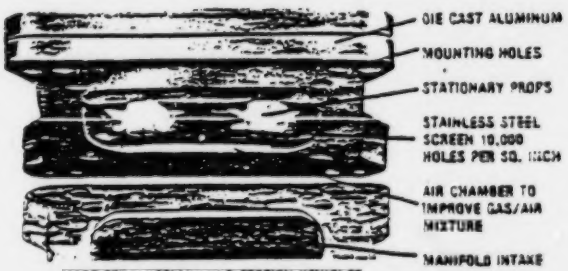
IN TEST RESULTS:
THINK OF IT! Even a 20% INCREASE would be like getting 24 cents EXTRA GASOLINE per gallon that you buy at $1.20 per gallon! Most vehicles tested were in the 20-PLUS-Range of INCREASE Highway Driving.

1978 Eldorado Cadillac, 500 cu. in. Eng. from 16.99 to 22.97 Increase 35%

1973 Chevy 9 pass Wagon, 400 cu. in. Eng. from 17.0 to 22.20 Increase 30%

Test Results Available on above and other vehicles on request.

Don't be fooled by the claims of those who offer devices to increase mileage, but actually restrict the flow of air. (Window Screen (256) holes per sq. inch, BLOCKS OUT about 40% AIR FLOW). The PATENTED TURBO-CARB compensates for AIR restriction by redirecting the flow of air from the carburetor through an Enlarged Air Chamber. It ALSO acts as a heat riser to pre-heat the mixture and AID distribution! CARBURETOR MANUALS say, for efficiency, performance, and less pollution, the fuel must be atomized and vaporized! Place a drop of liquid on your hot intake manifold and watch it spread out, but a fine micro-size speck will instantly vaporize! A course spray and large drops of fuel pass from carburetor into intake manifold, making it almost impossible to completely vaporize and mix with the right amount of air. You see why much of your fuel is wasted and not burned! That's one reason car manufacturers use a catalytic converter in the exhaust system to burn the unburned gas, which should have been burnt in the engine! With the PATENTED TURBO-CARB fuel saver, large liquid droplets of fuel are broken into a fine micro-size particles. With a potential of 10,000 per square inch! This makes the fuel much easier to vaporize, while a stationary prop provides propulsion turbulence to mix and direct the "fog-like" atomized fuel against the hot intake manifold walls, for more complete vaporizing, energizing and economy! With less pollution of hydro carbons and longer engine life! TURBO-CARB fuel saver has unique PATENTED FEATURES! Why not SPINNING PROPS? Because the AIR FLOW Controls the Props, SO Where's Resistance to cause Turbulance and Mix? STATIONARY PROPS Tested an increase over the Spinning Props! There are no moving parts to wear out, or electrical parts to burn out,-or cause fouling or stalling of your engine! And it's safe when properly installed. Mounts under carburetor, mounting instructions, bolts and gaskets included.



MADE FOR AMERICAN AND FOREIGN VEHICLES

HOW TO ORDER:

1. Check which model needed below
2. Check hose clearance between air-cleaner and hose on your vehicle. You will need 1 inch all models, except 4-barrel dual and square bore, 1 3/8 inch needed, less orifice gasket. To check, place MODEL thickness of hose broad on high point of air cleaner. Hose must "open" and if dead is compressed, reduce by thickness of orifice gasket to find needed clearance, and/or if possible to install on your vehicle.

NOTE, hose may possibly be adjusted at the flanges and latch, and/or insulation if any over the air cleaner cut out to get added clearance.

MODEL	DESCRIPTION:
No. 1	SINGLE BARREL, (2-bbl only), US and FOREIGN makes, including side-draft model cards.
No. 2A	DOUBLE BARREL—Honda, Datsun, Toyota (exc. 20R engine), Mazda, Opel, Audi, Subaru, Volkswagen Rabbit, Datsun Scirocco
No. 2	DOUBLE BARREL, (2 & 4 bbl), US makes (exc. AMC & GMC 1980 & 81 4 cy 151 and V6-173, and those listed in Model 2B) FOREIGN makes—Luv, Fiesta, Dodge Colt, Challenger, Plymouth Arrow, Lancer, Sapporo, Colt, Courier, Fiat, Volkswagen with Holly 2110 carb
No. 2B	DOUBLE BARREL—GMC V6 1979-81 196, 200, 229 and 231 engine 4" base; GMC V8 (as available at this time) 1977-79 301, 1978-81 250, 1979-81 267 and 305 engines
No. 4	FOUR BARREL—AMC V8 1967-74, GMC V8 1957-58, Chrysler V8 1964-72 single carb except Carter TQ, Ford V8 1957-74 except 351CJ & 460 Police
No. 4D	FOUR BARREL, Spread Bore & Quadrajet—AMC V8 1975-78, Ford V8 1975-78 and 1972-74 351CJ and 460 Police, GMC V8 1968-81 Quadrajet, Chrysler V8 1971-81 Carter TQ carb. (Ford and AMC eng. not available yet on this model.)

NOTE, Shipments usually made within 48 hours of receipt of your order when inventories permit. A limited supply is available for immediate delivery and subsequent orders will be filled as soon as production is able to meet demand. Please allow up to (60) days for delivery.

© Copyright 1980 by FUGETT PRODUCTS CO., INC. ALL RIGHTS RESERVED

FREE 30 DAY TRIAL—If for any reason you are not fully satisfied with your purchase of a TURBO-CARB, return within 31 days after delivery for FULL REFUND! Any unit which fails to operate properly due to manufacturing error, Fugett Products Co., Inc., offers FREE part replacement service on any part returned within 6 months of purchase, installation or removal excluded.

PLACE YOUR ORDER NOW! As there is a LIMITED SUPPLY. If demand is greater than we are tooled up for, it may take months to re-tool! So Hurry! Get your order in early. Don't be left out! Order one for each vehicle! And Save! Postage and handling PAID with order of two or more TURBO-CARBS!

SAVE! $3.00 EACH—ORDER WITHIN 10 DAY'S OF POSTMARK AND DEDUCT FROM PRICE ON COUPON—Include Postmark as Proof.

FUGETT PRODUCTS CO., INC. R.R. 2 BOX 221 GASTON, IN 47342

FEB 6 1981

MODEL:

1 ☐	2A ☐	2 ☐	2B ☐	4 ☐	4D ☐	
$44.95	$44.95	$49.95	$49.95	$54.95	$54.95	$ _____

Plus $2.00 Postage and Handling
Post Paid on Orders of two or more $ _____

IN. Residents Add 4% Sales Tax $ _____

☐ CHECK ☐ MONEY ORDER TOTAL $ _____

YEAR	MAKE	MODEL	ENGINE SIZE
1979	Plym. Sta	Volare	225 Cu. In.
1979	Ford	Granada	302 2 bbl
1979	Ford	Fiesta	2.3L 4 cyl

NAME: _____

ADDRESS: _____

CITY: _____ STATE: _____

ZIP _____ PHONE _____

NTIS is authorized to reproduce and sell this report. Permission for further reproduction must be obtained from the copyright owner.